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Notes and Comments

Puccinia oxalidis Dietel & Ellis (1895): first report controlling oxalis latifolia kunth (Oxalidaceae) in systems of direct planting

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The genera *Puccinia* (Pucciniaceae) includes more than four thousand species of fungi described (Kirk et al. 2008), mostly restricted to one host. The species diversity of Pucciniaceae is greatest in the genera *Puccinia* and *Uromyces* (Van der Merwe et al., 2007). The fungus *Puccinia oxalidis* Dietel & Ellis (1895) (Pucciniaceae), native to the southern part of the United States of America, Mexico, and South America (Šafránková, 2014), has been reported in the southern United States, Australia, China, India, Japan, Central and South America, New Zealand and South Korea (Farr and Rossman 2018; Lee et al., 2019). *Puccinia* species are pathogens of plants cultivated or not from different families, mainly Asteraceae, Cyperaceae, Fabaceae, Lamiaceae, Liliaceae, Malvaceae, Poaceae, and Oxalidaceae (Marin-Felix et al., 2017; Talhinhas et al., 2019).

Oxalis latifolia Kunth, originally from Mexico (Burger, 1991), a perennial plant with slow growth (Everard et al., 2018) and leaves in long petioles composed of three broad leaflets, is commonly known as "clover" or "sorrel" with asexual reproduction (bulbs). This species has been described as a weed in agricultural crops (Shrestha et al., 2019) and as a host of different rust-causing *Puccinia* species (Vacacela Ajila et al., 2018).

Fungal plant pathogens are increasingly recognized and studied worldwide for the biological control of invasive weeds (Ireland et al., 2019; Maharjan et al., 2020).

The hypothesis studied is that *P. oxalidis* can control *O. latifolia*, reducing or avoiding the use of chemicals to manage this plant in less disturbed systems such as in no-till vegetables. The objective of this work was to describe the occurrence of biological control of *O. latifolia* by *P. oxalidis* in no-tillage under straw in the culture of garlic.

The fungus *P. oxalidis* was observed between August and October 2018 on *O. latifolia* plants in the experimental area of the Olericulture sector of the Federal University of Jequitinhonha and Mucuri Valleys (UFVJM), municipality of Diamantina, located in the Espinhaço Meridional region, Minas Gerais state, Brazil (18°10'S and 43°30'W; 1387 masl). The local climate is Cwb - dry winter subtropical highland, according to the Köppen classification (Köppen, 1936), with dry winters and rainy summers. The minimum temperature was 15°C, the maximum was 23°C and the rainfall was 67.70 mm. The local soil is classified as Typical Ortic Quartzene Soil, according to the Brazilian Soil Classification System (SiBCS).

Samples of *O. latifolia* plants were collected and placed in Petri dishes and taken to the phytopathology laboratory of the UFVJM for analysis under a microscope and identification.

The propagation structure of *O. latifolia*, as resistant bulbs, allows surviving under different temperature and soil conditions and reinfestation by this weed until 140 days under no-tillage (Arianoutsou et al., 2010). In addition, the high number of seeds with rapid germination after stresses, such as the application of the desiccant herbicide for straw formation, may have favored the reinfestation by *O. latifolia* (Royo-Esnal and López-Fernández, 2010).

The fungus *P. oxalidis* covered the leaves of *O. latifolia* under no-tillage with the presence of pustules and urediniospore (Figure 1C and D). The sperm and aecial stages of this fungus were observed and its basidiospores germinated and penetrated the leaves (Guerra et al., 2019) of *Oxalis* spp. *Puccinia oxalidis* dinfested and causes rust in *O. latifolia* with powdered pustules on the abaxial surface of infected leaves (Lee et al., 2019), which quickly become powdery (Versluys, 1977), reducing growth and causing the wilting and death of this plant (Figure 2). The golden yellow color of rust urediniospores of *P. oxalidis* is due to the carotenoid pigments accumulated in the lipid droplets in its structure (Wang et al., 2019).

Puccinia spp. develop better and sporulate on the target plant, without damage to the crops, due to the microclimate of the decomposing straw in no-tillage, controlling different weeds like *Fallopia japonica* (Ueda et al., 2018). The straw can improve the environment for natural enemies (Trewavas, 2004), like this fungus, due to humidity and

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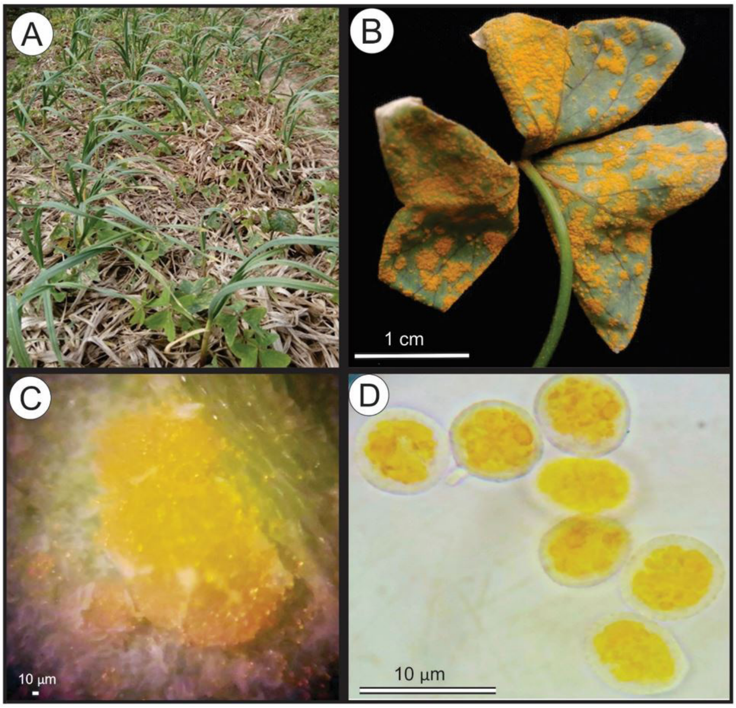

Figure 1. Clover (*Oxalis latifolia*) under no-tillage of the *Allium sativum* L. culture (A), rust caused by *Puccinia oxalidis* on the abaxial surface of the clover leaf (B), *P. oxalidis* pustules under a stereomicroscope (magnifying glass) (C), *P. oxalidis* urediniospore with circular shape (D).

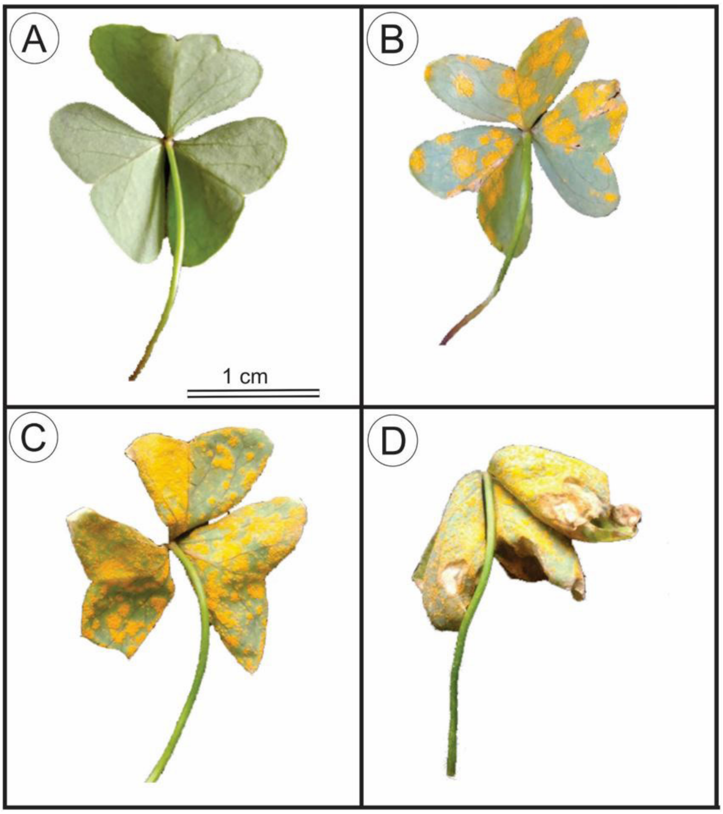

Figure 2. Stages of infection by *Puccinia oxalidis* in clover (*Oxalis latifolia*). Clover leaf without rust infection (A), onset of rust infection (B), rust across the leaf abaxial surface (C), leaf severely infected with symptoms of wilt and necrosis (D).

mild temperatures while reducing the competition between *O. latifolia* and garlic plants. The biological control by the fungus *P. oxalidis* prevented the competition of *O. latifolia* with garlic plants in no-tillage, even though it was the main weed species at 60 days after the beginning of this culture.

The weed *O. latifolia* predominated in the plots with no-tillage, but the rust on its leaves, caused by the fungus *P. oxalidis* reduced the competition, making additional weeding during the garlic plant cycle unnecessary for the management of this weed.

The biological control of *O. latifolia* by *P. oxalidis* was efficient without affecting the garlic plants under no-tillage.

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